Available online at www.scholarsresearchlibrary.com

Scholars Research Library

Der Pharmacia Lettre, 2017, 9 [7]:107-113
[http://scholarsresearchlibrary.com/archive.html]

ISSN 0975-5071
USA CODEN: DPLEB4

COMPARISON BETWEEN NEUTRON FLUX PRODUCTION WITH ELECTRON AND PROTON ACCELERATOR

Abdessamad Didi[1*], Ahmed Dadouch[1], Hassane El Bekkouri[1], Otman Jaï[1], Jaouad Tajmouati[1], Mohamed Bencheikh[1], Fatim-Zahra Bouhali[1]

[1]Laboratory of Integration System and Technology Advanced (LISTA), Department of Physics, Faculty of Science Dhar Mahraz , Universty of Sidi Mohamed Ben Abdellah Fez Morocco.

***Corresponding author:** Abdessamad D, Department of Physics, Faculty of Science Dhar Mahraz , Universty of Sidi Mohamed Ben Abdellah Fez, abdessamad.didi1@usmba.ac.ma*

ABSTRACT

Monte Carlo simulations have been carried out on targets at given thicknesses and diameters, bombarded by electron beams and protons with an energy of 18 MeV. The neutron yields escaping from the outer surfaces of the targets were calculated. In this article we calculated and compared the neutron flux produced by two types of accelerators. Key words: Solubility, Dissolution, Simvastatin, Cocrystals, Conformers.

Keywords: *AD, Electron, Proton, Neutron activation, Standard material, Gamma spectrometry*

INTRODUCTION

Generally, neutrons are produced by nuclear reactors and neutron sources [1-2], and with the availability of data on cross sections for photoneutrons [3], the application potential of ADS based electron or protons increases [4], not only in medical applications [5-6], but also in other research areas [7]. The neutrons can be used in several applications such as neutron activation analysis [8]. The simulation of the yield of the neutrons to be created by the targets bombarded by electrons or protons was studied very early in years [9-15]. This article gives a comparison between neutron flux based on electrons and based on protons or describe the performance and the nature of the target, their design geometry, size and target materials for a maximum neutron flux [16-17].

METHODS AND MATERIALS

This publication purpose the accelerator system (ADS) was studied to find an optimal material to use as a neutron converter; We performed several simulations with the MCNP-6 code using heavy materials (Tantalum, Lead and Tungsten) [18-19], The accelerator operates under an electrical current of 10 mA generates with the intermediary of the targets a neutron flux, a simple geometry realized using the Monte-Carlo MCNPX code [20]. The target is designed to generate the maximum number of neutrons. A study of the target material and the geometry to maximize the rate of neutron generation must first be performed. in this study, we are varied the thickness of 0 to 5 cm and the diameter fixed to 2 cm, (Figure 1).

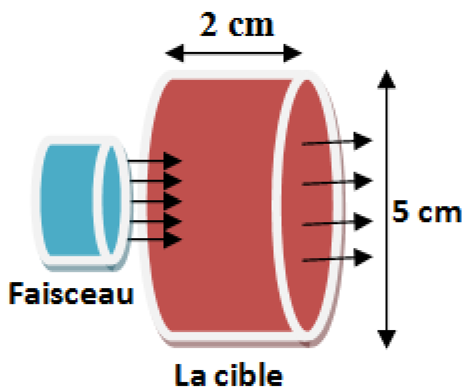

Figure-1: The graphical representation of the target.

In an electron or proton acceleration system, there is a heavy metal converters target (Pb, Ta and W) to convert electrons into gamma rays and then gamma rays into neutrons (Photoneutron). In other words, the two interactions (e, γ) and (γ, n) would occur within the converter target. The availability of the Monte-Carlo MCNP-X code and MCNP-6 as a simulation tool [20-21], it is possible to simulate a beam of electrons or protons of energy in targets. Optimizations of the target design directly related to the production and yield of photoneutron Bremsstrahlung in targets irradiated by an electron beam or protons [22-25].

However, using the nuclear data supplied by the ENDF.B.VII library [20-21] and [26], the problem geometry realized using the MCNP-X code and simulations using MCNP-6 code. The cleanliness and threshold energy of each material to produce neutrons of each target used are described in (Table 1) [5] .

Table 1: Radioisotopes, cross section and threshold energy of each material

Cible	Density	Isotopes	Abondance %	Threshold energy of (γ,n) reactions by MeV	Perak cross section (mb)
Lead (Pb)	11.35	$^{206}_{82}Pb$	24.10	8.09	
		$^{207}_{82}Pb$	22.10	6.74	
		$^{208}_{82}Pb$	52.40	7.37	

Tungsten (W)	16.654	$^{180}_{74}W$	0.12	8.41	415
		$^{182}_{74}W$	26.3	8.07	475
		$^{183}_{74}W$	14.28	6.19	500
		$^{184}_{74}W$	30.70	7.41	585
		$^{186}_{74}W$	28.60	7.19	650
Tantale (Ta)	19.3	$^{181}_{73}Ta$	99.99	7.58	
Beryllium (Be)	1.848	$^{9}_{4}Be$	100	1.67	5

RESULTS AND DISCUSSION

After several neutron simulations with Monte-Carlo code (MCNP-6) for both ADS the neutron flux and maximum in the case of thickness inferior to 5 cm and the optimum diameter and 2 cm, (Figure 1), will devote the study to making a neutron flux comparison of the several targets, (Table 2) tabulates the results of each ADS for the three targets. The results find by simulation using the MCNP-6 code, keeping the variables and the same parameters are represented in the form of tables and figures. As a remark from (Table 2), by a first view that the neutron flux generated by the two types of accelerators varies according to type of accelerator, for example the neutron flux produced by ADS with proton base more intense than the flux Neutron produced by ADS based electron, also the intensity of the flux varies with the type of target for both accelerators. The Ta is a target generates more neutron for both ADS followed by the W.

Table 2: Comparison between neutron flux production as a function of electron-based ADS and proton-based ADS

Neutron Flux (n/cm²s)						**Thickness (cm)**	**Diameter (cm)**	**Electric power (e/s)**	**Beam energy (MeV)**
Electron-based ADS			**Proton-based ADS**						
Pb	**Ta**	**W**	**Pb**	**Ta**	**W**				
0	0	0	0	0	0	0	2	$5.94\ 10^{15}$	18
$1,24\ 10^{12}$	$2,56\ 10^{12}$	$1,25\ 10^{12}$	$2,83\ 10^{12}$	$5,37\ 10^{12}$	$4,00\ 10^{12}$	1			

1,2310^{12}	2,48 10^{12}	1,21 10^{12}	2,73 10^{12}	5,18 10^{12}	3,87 10^{12}	2			
1,16 10^{12}	2,33 10^{12}	1,13 10^{12}	2,58 10^{12}	4,90 10^{12}	3,65 110^{12}	3			
1,06 10^{12}	2,1210^{12}	1,03810^{12}	2,3910^{12}	4,54 10^{12}	3,38 10^{12}	4			
9,55 10^{11}	1,91 10^{12}	9,34 10^{11}	2,18 10^{12}	4,13 10^{12}	3,08 10^{12}	5			

The following (Table 3) shows the neutron flux production rate as a function of thickness and the types of targets, the percent values are calculated by the application of the formula 1.

$$\boldsymbol{Production\ rate}\ \% = \frac{\boldsymbol{Neutron\ flux}}{\boldsymbol{Beam}} \qquad (1)$$

Table 3: Comparison between percentage of neutron flux production as a function of electron-based ADS and proton-based ADS

Neutron rate production (e/flux) %						**Thickness (cm)**	**Diameter (cm)**	**Electric power (e/s)**	**Beam energy (MeV)**
ADS-Base Electron			**ADS-Base proton**						
Pb	**Ta**	**W**	**Pb**	**Ta**	**W**				
0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0	2	5.94 10^{15}	18
0,021%	0,043%	0,020%	0,048%	0,090%	0,067%	1			
0,021%	0,042%	0,019%	0,046%	0,087%	0,065%	2			
0,020%	0,039%	0,017%	0,043%	0,082%	0,061%	3			
0,018%	0,036%	0,016%	0,040%	0,076%	0,057%	4			
0,016%	0,032%	0,000%	0,037%	0,070%	0,052%	5			

(Figure 2) represents the graphical presentation of neutron flux generated by the two types of accelerators (electron-based and proton based) and the target Pb, Ta and W respectively. Note that the flux generated by the proton-based, Ta targets is maximum a thickness equal of 1 cm, am by W to base proton then Pb to base proton, at the end the neutron flux generated by the three electron-based targets. After all calculus ,ADS based proton is more efficient for maximum neutron production.

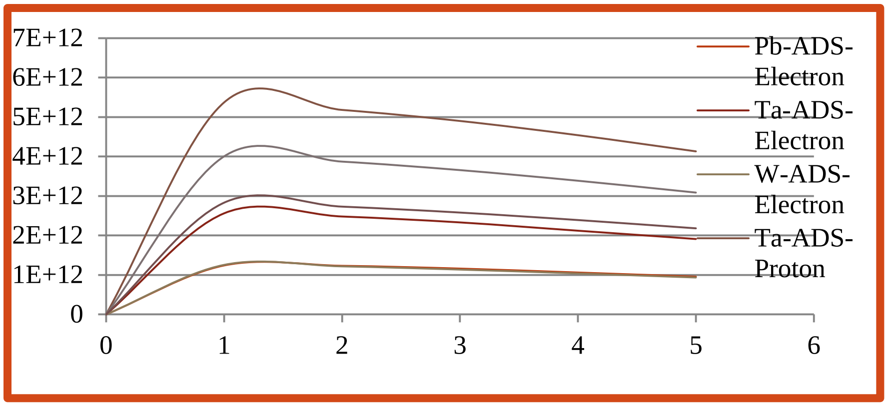

Figure-2: Comparison between the neutron flux generated by ADS-electron and ADS-proton

(Figures. 3,4) and schematize the neutron flux generated by each target using the two ADSs.

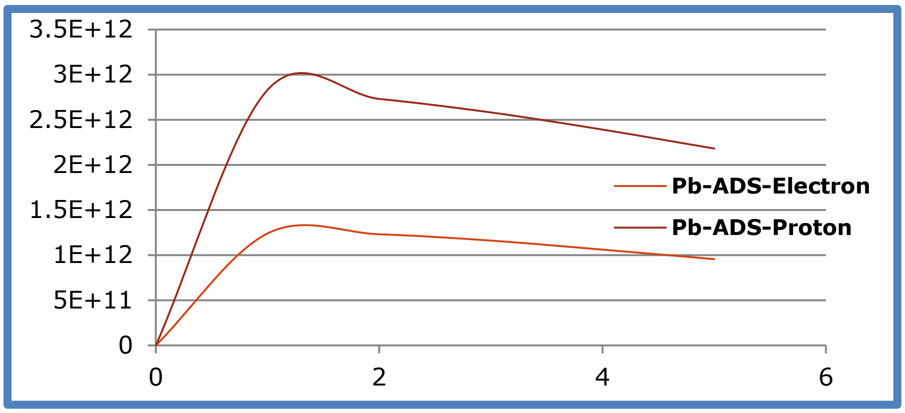

Figure-3: Comparison between neutron flux generated by Pb-ADS-electron and Pb-proton.

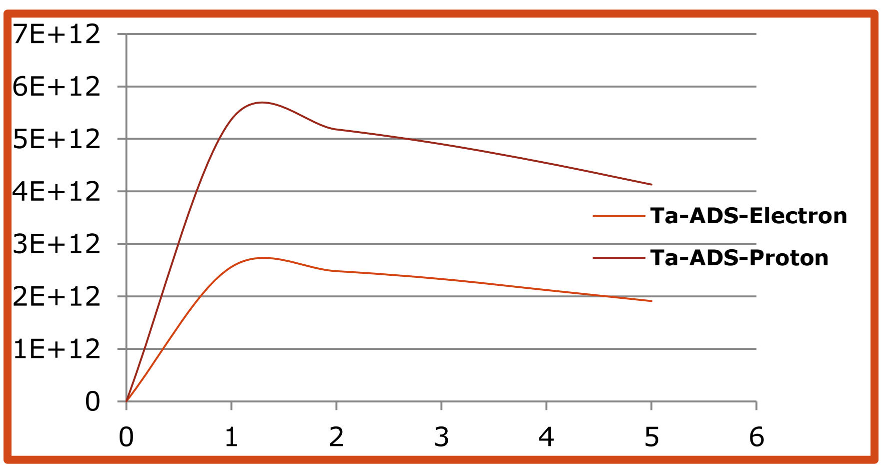

Figure-4: Comparison between neutron flux generated by Ta-ADS-electron and Ta-proton

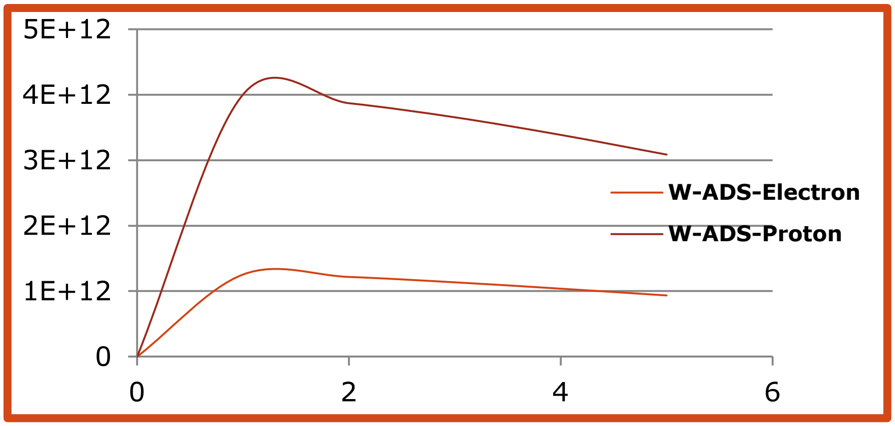

Figure-5: Comparison between neutron flux generated by W-ADS-electron and W-proton.

CONCLUSION

After comparing the flux produced by electron-based ADS and proton-based ADS, the results show that the neutron flux is maximal in the case of an ADS-proton. By designing the neutron product are a few MeV, which means that are fast type neutrons, this study gives an opportunity for the production of thermal neutrons by adding a moderator who can play a role of neutron deceleration, for the purpose of Production of radioisotopes using the neutron activation method.

REFÉRENCES

[1] Didi, A., *et-al* , *Int J Pharm Pharm Sci*, **2016**, 8 (11):327-331.

[2] https://doi.org/10.1016/j.net.2017.02.002

[3] Milazzo, PM., *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms*. **2004.** 36-41.

[4] Glinatsis, G., *Annals of Nuclear Energy*, **2017.** 1–8.

[5] Tabbakh, F., A New Library for Nuclear Science and Engineering, " *J. Nuc. Rela. Tech*, **2012**. 48.

[6] Dikiy, NP., *Proceedings of Conference.* Stockholm, Sweden: Conference, **1998**: 2389-2391.

[7] Liu, Y., Yaxi, North Carolina State University, **2006**.

[8] Didi, A., *et-al*, *Der Pharma Chemica*, **2016.** 8(5): 250-255.

[9] Berger, JM., *Phys Rev*, **1957.** 105: 35–38.

[10] Kneissl, U., *Nucl Phys A*, **1975.** *247*: 91-102.

[11] Pottier, J., *Nuc. Instr. Methods Phy. Rese. B*, **1989.** 40(41): 943-945.

[12] Kim, GN., *J. Accel. Plasma Res*, **1998.** 3: 9-17.

[13] Akkurt, J-O Adler, *Phys. Med. Biol.*, **2003.** 48: 3345–3352.

[14] Haug, E., *Astron. Astro. Phys.*, **2003.** 406: 31–35.

[15] Chen, J., *Accelerator-Driven Sub-critical System Characterization,* ADSS Experiments Workshop, **2006**

[16] Rahmani, F., *App. Rad. Isotopes,* **2015.** 106:45-48.

[17] Huang, WL., *Nucl. Instrum. Methods Phys. Res. B,* **2005.** 229:339–347.

[18] Martin, B., *J. Phys. Rev. C,* **1970.** 2: 621-631.

[19] Seltzer, SM., *Phys.Rev. C,* **1973.** 7: 858-861 .

[20] Auditore, L., *Nucl. Instr. Meth. Phys. Res. B,* **2005.** 229:137–143.

[21] Pazirandeh, A., *Appl.Radiat. Isot.* **2011.** 69:749–755.

[22] Tsechanski, F., *Nucl. Instr. Meth. Phys. Res. B: Beam Interactions with Materials and atoms*, **2016.** 124-139.

[23] Lambert, RP., *Nucl.. Instr. Meth. Phys. Res.*, **1983.** 214:349-360.

[24] IAEA., *Handbook of photonuclear data for applications: Cross section and spectra,* . Vienna: TECDOC-1178, **2000**.

[25] Ongaro, A., "Analysis of photoneutron spectra produced in medical accelerators." *Phys. Med. Biol.,* **2000**. 45:L55–L61.